**TEXAS COMMISSION ON ENVIRONMENTAL QUALITY**

**WATER SUPPLY DIVISION STAFF GUIDANCE**

# Review of Reverse Osmosis Membrane Filtration for the Treatment of Secondary Contaminants for Groundwater Sources

## I. Background

***Rules Applicable: 30 TAC §290.39(l), and §290.42(g)***

Title 30 Texas Administrative Code (TAC) §290.42(g) of the Texas Commission on Environmental Quality (TCEQ) rules allows systems to utilize treatments that do not have specific design criteria in the rules by requesting an exception to the rule. If the exception is approved, TCEQ establishes site specific design, operation, maintenance, and reporting requirements for the treatment. Because the rules do not have design, operation, maintenance, and reporting criteria, the exception approval letter establishes the criteria for the treatment.

To approve alternative treatments, the rules require a licensed professional engineer to provide pilot test data or data collected at similar full-scale operations to demonstrate that the proposed treatment will produce water that meets the requirement of Title 30 TAC Chapter 290, Subchapter F: Drinking Water Standards Governing Water Quality and Reporting Requirement for Public Water Systems.

As a response to the 2011/2012 drought emergencies, the TCEQ began developing a streamlined brackish groundwater desalination project review process, while still ensuring that the required quality and quantity of drinking water was protected. To achieve this goal, the TCEQ worked with a balanced group of stakeholders to identify potential alternatives to pilot studies for brackish groundwater reverse osmosis (RO) membrane filtration and provide solutions for the development of additional water supply options for the state.

Based on input from stakeholders on the reliability of computer modeling for brackish groundwater RO treatment plant design, TCEQ has determined that these computer models can effectively demonstrate membrane performance for a specific RO configuration. The TCEQ will therefore allow computer modeling in lieu of onsite pilot studies for RO filtration for secondary contaminants from a groundwater source. Models cannot be used as a substitute for pilot studies for a source that has been deemed to be groundwater under the direct influence of surface water. The computer model results will provide the capacity and water quality information necessary for TCEQ to approve an exception.

## II. Purpose of this Staff Guidance

This Staff Guidance is intended to facilitate consistent and timely review by the TCEQ staff of exception requests for RO systems for the treatment of secondary contaminants from a groundwater source. The Staff Guidance will be the basis of a TCEQ written response stating whether the submittal was acceptable or unacceptable and will specify the deficiencies of an unacceptable submittal. The "reviewer" is the TCEQ staff assigned to evaluate the submittal. The "engineer" is the person who submitted the exception request. The reviewer should make reasonable attempts to contact the engineer if information is missing or incomplete. TCEQ's written response will contain site-specific design, operation, maintenance, and reporting requirements. These requirements will be used by the engineer to develop the required engineering plans and specifications for the proposed membrane installation.

# III. Engineering Design Report – Checklist

If a public water system wishes to submit computer model results in lieu of performing the pilot study required under 30 TAC §290.42(g), the following information should be submitted. The items marked with an asterisk (*) are required items.

## General Information

☐*Signed and sealed by a Texas P.E.
☐*Name of the Public Water System (PWS).
☐*PWS ID Number.
☐*flow and volume data reported in English units.

## Project Summary

☐*Brief overview of the project including a statement of the problem(s) and proposed solution.
☐*Description of existing PWS infrastructure including sources, treatment, and current connection count.
☐*Description of current and projected treated water volumes needed including the number of connections and population to be served in the future.
☐*Description of proposed site for the treatment plant and new wells.
☐Adequacy of facilities with regard to delivering capacity and pressure throughout the system (if included in the project).
☐*Authorization from groundwater conservation districts (if needed).

## ANSI/NSF Confirmation

☐*ANSI/NSF – Standard 60 certificates for all proposed treatment chemicals.
☐*ANSI/NSF – Standard 61 certificate(s) for any chosen membrane.

## Basis of Design

### Raw Water Quality

☐* Name and location of the source water proposed for treatment. All known wells must be identified.
☐*If proposed to use new sources, explanation of how the raw water quality data included in the report is representative of the water quality to be found at the new source(s).
☐Hydrogeology study including:
- ☐Stratigraphy expected to be encountered by well drilling (Geological profile including aquifers and confining layers, depths and thickness);
- ☐Projected source volume (in acre-ft) and quality variability expected in the future;
- ☐Impact of proposed pumping on the water levels of the source aquifer(s) and other proximate strata.



*Required items

☐*Table of the chemical quality constituents of the untreated source including:
- ☐*The number of samples taken;
- ☐*Date when samples were taken.
- Range (minimum and maximum) sample results for:
  - ☐*Silt density index (SDI);
  - ☐*All primary and secondary regulated constituents;
  - ☐*Any constituent indentified as either a potential foulant (or scalant) by the membrane vendor (Identify all model input);
  - ☐*Other water quality parameters required by the membrane-specific computer model.

☐*The safety factor used and an explanation of how the safety factor was determined.
☐*Copies of all the laboratory results for the sample results shown in the table above.
☐*Laboratory NELAP accreditation. If a laboratory is not NELAP accredited, include copies of the QA/QC samples and results performed by the non accredited lab.
☐If test well or current source information is available, include coliform levels in the source water.

### Finished Water Quality Goals
☐*The finished water quality goals based upon regulated and/or owner specific standards.

### Process Flow Rates
☐*Proposed operating flow rate of the RO system, including the feed, permeate and concentrate streams.
☐*Proposed operating flow rate of the RO bypass stream (if any).
☐*Proposed operating flow rate of pre and post treatment processes.

## Design Criteria

### Process Flow Description
☐*Description of the overall proposed treatment process(es).
☐*Process Diagram.
☐Hydraulic Profile.

### Pretreatment
☐*Description of water quality parameter pretreatment is addressing.
☐*Detailed description of pretreatment process.
☐*Design criteria for pretreatment equipment.

### RO Treatment
☐*Description of the RO configuration including stages and passes.
☐*RO manufacturer name(s) and model number(s).
For each proposed unit:
- ☐*Membrane element surface area;
- ☐* Oxidant resistance;
- ☐* Feed water limitations (turbidity, metals, minerals, SDI);
- ☐*Maximum allowable net driving pressure;
- ☐*Recommended operating temperature range;
- ☐*Recommended pH levels.



*Required items

Computer model information for each proposed unit:

- ☐*Description of manufacturer's model including version and date run;
- ☐*At least 2 modeling results for each proposed unit. One for a new and one for a fouled membrane condition;
- List of inputs required to run the model such as:
  - ☐*Number of elements;
  - ☐*Number of stages;
  - ☐*Number of passes;
  - ☐*Flow (or fouling) factor (for new and fouled membranes);
  - ☐*Recommended operating pressure range
  - ☐*Percent recovery
- List of assumptions made in the modeling such as:
  - ☐*Recommended operating flux range for a groundwater source;
  - ☐*Maximum lead element permeate flux rate;
  - ☐*Maximum and minimum element inlet flow;
  - ☐*Minimum and minimum element outlet flow;
- ☐*List of any chemical constituents of concern expected in the proposed source not reflected in the model;
- ☐*Model results.
- ☐*Safety factor and description if applied

### Post Treatment (including blending)

☐*Description of water quality parameters post treatment is addressing.
☐*Based on total organic carbon (TOC) and other precursor sample results, a description of the Disinfection Byproduct (DBP) formation potential.
☐*Detailed description of post treatment process.
☐*Design criteria for post treatment equipment or process.

### Chemical Cleaning Systems

☐*Description of types of fouling expected.
☐*Description of cleaning process.
☐*Description of estimated interval between cleaning.

## Residuals Management

☐*Describe the characteristics of the waste stream(s).
☐*Describe the projected volume of the waste stream(s).
☐*Describe the expected disposal method(s) (i.e. UIC Disposal well, wastewater treatment plant, discharge permit, etc.).
☐*Describe permits or authorizations obtained or needed.

## Proposed Operational Procedures

☐*Operator training plan.
☐*Process control sampling and recording keeping.



*Required items

## Instructions for Review of the Engineering Design Report by TCEQ Staff

The following sections describe the process and criteria used by TCEQ staff to review the submitted Engineering Design Report with computer modeling results to support a request for an exception to use reverse osmosis for the treatment of brackish groundwater.

# IV. Review of the Engineering Design Report – General Information

- The engineering report submitted seeking approval of an exception to use alternative treatment should not include the approval for the construction of the full scale facility. The construction of the facility may not begin until the site-specific final engineering plans and specifications for the project, either modifications to an existing treatment plant or the design of a new full-scale water treatment plant, have been reviewed and approved for construction

- The report should contain all the required items specified in this document.

- The report must be prepared by the system's professional engineer, licensed by the Texas Board of Professional Engineers, accompanied by a cover letter that is signed, sealed and dated by the licensed engineer.

- The report must identify the public water system (PWS) proposing brackish groundwater treatment with RO.

- The report should be submitted with flow and volume reported in English units of measurement.

If the report is not signed and sealed by a Texas P.E., or if the report's PWS cannot be identified, the report will not be reviewed.

# V. Review of the Engineering Design Report – Project Summary

The project summary allows the reviewer to understand the treatment goals, the treatment strategy, and the relationship between the project and the overall goals and needs of the public water system. Title 30 TAC § 290.39(e)(1) requires engineering reports to contain many of the items listed below. The project summary should include:

- A brief overview of the project including a statement of the problem(s) and the proposed solution(s).
  *The reviewer should be able to, in general, understand the purpose of the project, the project location, and the treatment technologies to be used. The reviewer should understand the challenges of the proposed treatment technologies and the general finished water goals.*

- A description of existing PWS infrastructure including sources, treatment, and current connection count.
  *The reviewer should use this information to understand the current size of the system and level of treatment currently being provided.*

- A description of current and projected treated water volumes based on the number of connections and population to be served in the future.

*The information provided should include projected water volumes, and projected connection counts and population. The reviewer should use this information to understand how the project will impact the overall system.*

- A description of the proposed site for the treatment plant and the new wells if the site location has been identified.
  *This information will only be provided if a site or possible sites have been proposed for the project. If a site or sites have been proposed, the reviewer should review any TCEQ known sources of contamination within a 1/4 mile radius of the well sites.*

- Adequacy of facilities with regard to delivering capacity and pressure throughout the system (if included in the project).
  *Though not required for the exception review, many engineering reports will include this section. This information will only be included if the project will include new distribution system lines or modifications to existing distribution systems. The reviewer should read this section to understand the entire project, but the information will not be a part of the review.*

- Authorization from groundwater conservation districts (if needed)
  *The report should state that the PWS is, or is not, located in a groundwater conservation district GCD. If the project is located in a GCD, the PWS should check with the GCD to assure approval to both drill the well(s) and pump the quantity of water anticipated. This information must be clearly presented in the report, including any limitations imposed by the GCD. If the PWS is not allowed to drill and pump groundwater, the report should explain how the required approval for well production capacity will be obtained.*

## VI. Review of the Engineering Design Report – ANSI/NSF Confirmation

According to 30 TAC §290.42(j), "All chemicals and any additional or replacement process media used in treatment of water supplied by public water systems must conform to American National Standards Institute/National Sanitation Foundation (ANSI/NSF) Standard 60 for direct additives and ANSI/NSF Standard 61 for indirect additives. Conformance with these standards must be obtained by certification of the product by an organization accredited by ANSI." The report should contain evidence that all of the chemicals, including membrane cleaning chemicals, conform to ANSI/NSF Standard 60 and the membranes conform to ANSI/NSF Standard 61.. As an alternative to ANSI/NSF Standard 61, a system may show certification to Standard 58. If another ANSI/NSF certification is supplied it should be evaluated on a case by case basis. The reviewer should assure that the engineer has demonstrated that all membranes and chemicals being considered have the appropriate ANSI/NSF certification

## VII. Review of the Engineering Design Report – Basis of Design

The basis of design contains the information that led the design engineer to choose the treatment process, equipment, and operating conditions for the proposed facility.

### Raw Water Quality

This section should provide the raw water quality analysis for the proposed facility. The data should clearly state relevant information such as the date(s) of sampling, location, and the parameters analyzed. The section should also provide the safety factors the engineer is proposing to use to

mitigate any uncertainty in the data. The section should include:

- Name and location of the source water proposed for treatment. Each individual existing well must be described. If the well sources are proposed, explain how the raw water quality data included in the report is representative of the water quality at the new source(s).
  *If the source is an existing PWS source, the source IDs should be included for all wells. The source IDs can be found on TCEQ Drinking Water Watch (DWW) at http://dww.tceq.texas.gov/DWW/. The reviewer should verify the sources and source IDs in the report are those in DWW.*

  *If the source is to be constructed, and the general location is known, the report should contain the approximate location of the wells. The report should indicate where the raw water quality data was attained and how this data represents the quality of the water at the site.*

  *If a location hasn't been identified for the source, the report must clearly explain how the engineer knows the raw water data presented is representative of the water at the facility. In these cases, a hydrogeologic study would assist in understanding the water quality variability.*

- If needed to validate production capacity or variability in water quality, then the engineer should include a hydrogeology study. The hydrogeology study should include: aquifers and confining layers, depths and thickness; projected source volume (in acre-ft) and water quality variability expected in the future; and the impact of proposed pumping on the water levels of the source aquifer(s) and other proximate strata.
  *If a hydrogeologic study is included, the reviewer should use the report to understand the variability of the source water quality and to determine if the raw water quality provided will be representative of the proposed source water.*

- A table of the chemical quality constituents of the untreated raw water source. The table should include the number of samples, sample location(s) (such as from individual wells or from a composite sample tap), and the date(s) of sampling.
  *The most recent sample set must have been taken within the last 5 years. Older data may be submitted to show variability or stability of the source water, but at least one recent sample set must be included.*

  *Ideally, 8 quarterly sampling events should be provided from the actual source or a test well(s) in the same location. Eight quarters of data will show variability if present. If there is water quality variability, the worst-case water quality data should be used in the model.*

  *If there are less than 8 quarters of data, the engineer must support the concept that the submitted water quality data is representative of the source. This should include documentation that the source is stable within the parameters of the submitted data. As an example, a hydrogeologic study would assist the reviewer in understanding the water quality variability.*

- The safety factor applied to the raw water quality constituents and an explanation of how the safety factor was determined.

  *At a minimum, the reviewer must have a reasonable basis to conclude that the applied safety factor will provide at least a worst-case water quality for the model. The report should clearly link the safety factor to the constituents of concern for both modeling and treatment*

*purposes. It is the responsibility of the design engineer to determine the appropriate safety factor. As an example, no safety factor might be applied if the source of the water is an existing well(s) with at least 8 quarterly samples. As another example, large safety factors would be needed if the water quality results were obtained from a well not located near the proposed site or from an aquifer that is not well studied or is quite variable.*

- The table of chemical quality constituents should also show the range (minimum and maximum) of constituent levels of the raw water samples before the safety factor (if any) is applied. Specific constituents in the table must include silt density index, all primary and secondary regulated constituents, any constituent indentified as either a potential foulant (or scalant) by the membrane vendor, or other water quality parameters required by the membrane-specific computer model. The constituents that are required computer model inputs should be identified in the table.

  *The reviewer should compare water quality data to all secondary and primary standards are listed in 30 TAC §290.104 and §290.105. Please be aware that this staff guidance is for the use of RO to remove secondary constituents only. This staff guidance is intended only to address secondary standards from a brackish groundwater source. If primary standards are also exceeded, the engineer should explain how compliance with those standards will be met. Depending on the method selected for primary standard compliance, the PWS may be required to do a pilot study to demonstrate that all primary standards will be met for the final treated water.*

  *The engineer should include any potential contaminants identified in a ¼-mile radius of the well in the raw water quality table and discussed as a potential source of groundwater contamination for the project.*

  *The engineer should include any constituent identified as either a potential foulant (or scalant) by the membrane vendor in the table. The list below is an example of common water quality constituents that should be evaluated for a reverse osmosis process.*

  *The reviewer should also look at the other water quality parameters required by the membrane-specific computer model. Some, such as high turbidity or TOC, may require post or pretreatment processes.*

***Suggested Raw Water Quality Parameters***

| **Cations** | | **Anions** | | **Other** | |
|---|---|---|---|---|---|
| Aluminum | | Chloride | | Alkalinity | |
| Ammonia | | Fluoride | | pH | |
| Barium | | Nitrate | | SDI | |
| Calcium | | Phosphate | | TDS | |
| Iron | | Silica | | TOC | |
| Magnesium | | | | TSS | |
| Manganese | | Sulfate | | Temperature | |
| Potassium | | | | Turbidity | |
| Sodium | | | | | |
| Strontium | | | | | |

- The report should include copies of all the laboratory results with a summary of the results in a raw water quality table.
  *The reviewer should verify that data in the summary table is the same data as found in the laboratory results. The reviewer should also verify that the analytical methods are the accepted methods as specified in 30 TAC §290.119.*

- The report should include a copy of the NELAP accreditation for the laboratory or should include the QA/QC samples and results performed by the laboratory.
  *If the laboratory is not accredited by NELAP, then the reviewer should examine the QA/QC samples and results for each constituent type analyzed to assure accuracy.*
- If a test well or current well source is available, the report should include coliform levels in the source water.
  *The reviewer should look at the total coliform results. If total coliform is found, the report should include a plan to address the found coliform and any further testing done for e. coli or other microbial contaminants. Based on the results and geology, the well may be groundwater under the direct influence of surface water. If so, rules and regulations apply to the well that is not addressed in this document. Appropriate treatment to remove microbial contaminants may require pilot testing depending upon the selected treatment method(s).*

### Finished Water Quality Goals

- This section should explain the finished water quality goals for the system. The goals may be the regulatory water quality standards, or may be owner specific standards above the regulatory limits or standards to address aesthetic issues.
  *The reviewer should verify that the goals meet or are more stringent than the TCEQ defined primary and secondary limits.*

### Process Flow Rates

This section should explain the flow rates expected from the treatment facility. The section should include:

- Proposed operating flow rate of the RO system including the feed, permeate and concentrate streams.
- Proposed operating flow rate of the RO bypass stream (if any).
- Proposed operating flow rate of other pre and post treatment processes.
  *These items will be used by the reviewer to evaluate the models and provide a capacity rating for the treatment units.*

## VIII. Review of the Engineering Design Report – Design Criteria

The design criteria section contains the detailed information on which the engineer bases the design. The information includes process flow description, pretreatment, RO treatment, post treatment and chemical cleaning systems.

### Process Flow Description

- The report should describe the overall proposed treatment process.
- The report should include a process diagram.
- The report may include a hydraulic profile of the treatment plant.

*The written description, process diagram, and hydraulic profile will give the reviewer an understanding of the treatment process as a whole. This information may be useful in identifying missing treatment components, incorrect sequence of treatment, parallel treatment trains, and blending locations. The hydraulic model is especially useful in understanding the available head, the loss of head through various processes, and pumping requirements.*

## Pretreatment

- The report should include a description of the water quality parameter(s) addressed by pretreatment.
  *Pretreatment processes are typically provided to address the following water quality parameters:*
  - *Inorganic compounds that may precipitate and cause scaling;*
  - *Organic foulants*
  - *Silt Density Index; and*
  - *Suspended solids and silt.*

  *The reviewer will compare the description provided with the raw water quality results, the manufacturers' requirements and the computer model outputs to ensure the appropriate pretreatment is provided, when necessary. Also, the reviewer will examine the sources of contamination within ¼ mile from the well, if available. If the SDI is above 3, there should be a discussion of pretreatment. No pretreatment may be chosen, but a discussion of why no pretreatment should be included. If the SDI is above 5, a pretreatment process should be identified.*

- The report should include a detailed description of the pretreatment process.
  *The pretreatment process should address the water quality parameters identified above. The process should be adequate to remove, or lower, the level of the constituent to the allowable feed water specifications of the RO membrane vendors. For example: chemical antiscalants, sodium bisulfite for chlorine removal, pH adjustment, other chemical addition, cartridge filters/screens for particulate removal, and filtration processes for iron removal. Ensure that the rules do not require a separate pilot study for that the treatment chosen. For example: water softeners (or other ion exchange processes) to reduce hardness and scaling.*

- The report should include the design criteria for pretreatment equipment including flow rates, loading rates, chemical doses, media specifications, process control, and other equipment and process considerations.
  *The pretreatment process should meet the design criteria in the 290 Subchapter D rules, if applicable. Chemical feed dosing should be detailed. Flow rates and NSF/ASNI 61 certification for media based treatment should be included. Refer to the rules, found in 30 TAC §290.42 and §290.46, and staff guidance documents for details about specific pretreatment requirements.*

## Reverse Osmosis Treatment

- The report should include a description of the RO configuration including stages and passes.
  *The reviewer should be able to clearly understand how the RO system will be configured. Details about each RO membrane manufacturer should be included if the configurations will be different. This information will be included in the site specific design requirements if the exception request is approved.*

- The report should include all RO products under consideration for the proposed plant. This must include the manufacturer name and model number for each considered unit. For each model, the report should include the RO element's specifications. The report can include model results from multiple manufacturers. Three different manufacturer's models are suggested. The specifications of interest include membrane element surface area, oxidant resistance, feed water limitations (turbidity, metals, minerals, SDI) and maximum allowable net driving pressure.
  *The reviewer should assess the water quality of the source (and the potential sources of contamination that may change water quality) and the feed water limitations. Appropriate pretreatment should be provided for the items outside the recommended levels. If an oxidant has been proposed in the process diagram, review the oxidant resistance of the membrane and any pretreatment provided to quench the oxidant.*

- As it pertains to membrane cleaning, the report should include the recommended temperature limits and pH range for the membrane.
  *This information will be used to review the proposed cleaning regime later in this section.*

## Computer Model Information

The report should contain the following computer model information for each proposed unit.

- The report should contain a brief description of each model, the model version, and the date the model is run.
  *The reviewer will use the manufacturer's website to determine if the computer model is correct for RO element(s) selected. Please note that different elements may be selected for different stages and the computer model may be able to support multiple RO element types.*

- The report should include at least 2 modeling results for each for each unit proposed. Modeling results should include a clean (new) and fouled membrane condition along with any changes in feed water quality that are expected.
  *At least two model runs will ensure that the system design can meet the flow needs over time.*

- The report should contain a discussion of how the proposed system was modeled. The report should include a list of inputs and assumptions required to run the model for the proposed source(s). The list should include feed water constituents, and other necessary inputs such as, number of elements, number of stages, number of passes, flow (or fouling) factor (for new and fouled membranes), recommended operating pressure range, recovery %, and flow and flux rates. The industry standard recommendation for the system flux rate for brackish groundwater should also be stated, along with the maximum recommended lead element flux and the minimum and maximum inlet and outlet flow rates to the membrane elements.

  *The reviewer will compare the feed water inputs to the raw source water analysis or to a feed water analysis based on pretreatment. The feed water inputs should include the safety factor determined in the raw water section of the report. All feed water data used to model the RO system must be site-specific information. If variation is expected in the water quality, the model runs should have different water quality inputs.*

  *The system's configuration shown in the model and the system configuration described in the report should be the same.*

  *The flow or fouling factor should match the suggested brackish water flow or fouling factor from the manufacturer for a new and fouled (end of life) membrane. If a different factor is used, there should be sufficient explanation for the change in the engineering report.*

- The report should list any chemical constituents of concern expected in the proposed source not reflected in the model and the proposed treatment or migration plan.
  *The reviewer should evaluate the source water quality for any constituents of concern that are not included in the model. The reviewer should then see if all of the constituents of concern not included in the model are included in the engineering report. The engineering report should explain how the constituents will be mitigated. The reviewer should ensure that the engineer included mitigation through post or pretreatment is included in the post or pretreatment sections.*

- The report should include a copy of the model results for at least two model runs. Typically, the model will provide a detailed report that can be printed and included with the engineering report. The report will include inputs, finished water quality, flow, flux, pressure and recovery, and possibly warnings of scaling. The engineer shall state the safety factors applied to the permeate quality projections. In lieu of a safety factor, the engineer can present results from at least 3 different manufactures.
  *The reviewer should compare the modeling projections to determine if the maximum lead element flux rate or the minimum and maximum inlet and outlet element flow rates are in violation of the membrane element's design guidelines. Also, check to assure the percent recovery within manufactures recommendations. Some models will provide warnings if recommended flux, flow rates, or recovery of the elements are exceeded.*

  *The reviewer should analyze the flow, pressure, flux, and recovery information to ensure that the proposed RO plant will meet the flow and water quantity goals proposed by the system. The reviewer should evaluate the pressures shown in the model to assure that they do not exceed the recommended operating pressure or the maximum allowable net driving pressure.*

  *The reviewer should assess the safety factor applied or see if 3 manufacturer's models have been used. If a safety factor is applied, the engineer should explain how the factor was obtained and how the factor mitigates any uncertainty in the model.*

  *Compare the results with the safety factor if multiple manufacturer models are used, the worst case water quality to the regulated limits and the water system flow and water quality goals. The model projections should be less than the regulator or water systems goals or post treatment should be specified.*

  *The reviewer should evaluate the warnings in the computer model results and assure that each warning that indicates scaling can occur has been mitigated through pretreatment or anti-scalant use. The reviewer should further investigate the proposed pretreatment and assure that items the models may be able to estimate, such as pH adjustment, have been properly modeled.*

## Post Treatment

- The report should include a description of the water quality parameter that the post treatment is addressing.
  *Post treatment processes are typically provided for:*
  - *Disinfection*
  - *Stabilization*
  - *Odor control*
  - *Blending*

*The reviewer should evaluate the permeate water quality in the computer model results and determine if post treatment concerns are satisfactorily addressed. In most cases, the aggressive permeate water will need pH adjustment and/or blending to protect against corrosion in the distribution system. Specifically, the reviewer should look at regulated contaminants in the projected finish water that may be above the regulated limit and discussions in the report regarding additional treatment to produce water that meets federal and state drinking water standards.*

- The report should include a detailed description of the post treatment process including flow rates, loading rates, and/or chemical dosage.
  *The post treatment process should address the water quality parameters identified in the bullet above. The process should be adequate to remove or lower the level of the constituent to the regulatory or water system specific goals. For example: pH adjustment, corrosion inhibition, blending or disinfection. The reviewer should ensure that the rules do not require a separate exception for the treatment chosen. For example, the use of chloramines requires a separate exception request if the system does not already have a granted chloramines exception. If the system would like to use chloramines, the exception can be granted with the request to use RO if the necessary documents are provided. See the Staff Guidance of Chloramines for details.*

- The report should include a discussion of the DBP formation potential. Based on TOC and other water quality results, the report should discuss whether DBP formation is likely. Projected DBP formation to levels above half the MCLs is considered significant and a solution should be discussed in the report.
  *If the report indicates that DBP formation is likely to be half the MCLs or higher, the report should include a plan to ensure that DBPs in the distribution systems will not exceed the MCL.*

  *If blending is proposed, where the blending occurs should be detailed (ex, ground storage tank, distribution). If blending is to occur in the distribution system or with another water source, special attention must be paid to stabilization and disinfection.*

  *Blending should be described in detail including: percentage of water from each source, estimated post blending quality, and monitoring used to control blending. Chemical feed dosing should be detailed. NSF/ASNI 60 certification for chemicals must be included. Refer to the rules and other staff guidance documents for details about specific treatment requirements.*

## Chemical Cleaning Systems

Chemical cleaning is needed when fouling and/or scaling prevents the membrane systems from producing the quantity and quality of water of new membranes. Although membranes can be replaced when their performance is no longer adequate, chemical cleaning systems can effectively extend the useful life of the RO units.

- The report should include a description of the types of fouling to be expected.
  *The reviewer should ensure that all expected foulants/scalants as found in the raw water (or feed water) data were addressed.*

- The report should include a description of chemicals used, chemical solution concentrations, temperatures and cleaning procedure duration(s) for each chemical cleaning procedure.

*The reviewer should ensure the cleaning method proposed is appropriate for the foulants/scalants and that the temperature and pH do not exceed those allowed by the manufacturer. The chemicals proposed must have ANSI/NSF Standard 60 Certification.*

- The report should provide the projected interval between cleanings and the criteria used to determine when chemical cleaning is needed.
  *The report should include an estimate of the cleaning interval. If the interval is less than 30 days, the TCEQ may reduce the approved capacity of the RO system with respect to the time out of service for cleaning during a 30-day period. There should be a discussion of how the water system will know that cleaning is needed.*

## IX. Review of the Engineering Design Report – Residuals Management

The Plan and Technical Review Section does not evaluate wastewater and residuals management for TCEQ approval. However, compliance with state and federal requirements for proper waste disposal must be addressed in the report. For the project to be implemented and successful, it must have a way to manage the residuals.

- The report should describe the characteristics of the waste stream(s), the volume of the waste stream(s), the expected disposal method(s), and the permits and authorizations already achieved or needed.
  *The reviewer should ensure that the water system has an acceptable plan for the RO waste removal/disposal. The reviewer should provide contacts to the engineer within the appropriate sections of TCEQ to process the needed permits or authorizations.*

## X. Review of the Engineering Design Report – Proposed Operational Procedures

- The report should include an operator training plan that details the amount and type of training the operators will receive for the RO membranes, pretreatment, and post-treatment equipment.
  *The report should include a detailed plan on how the operators will be trained both now and in the future. Both general classroom training and on-site training (potentially by the vendor) should be identified. Also, if analysis will be performed on site, a water laboratory class should also be included.*

- The report should include the proposed process control monitoring and record keeping program.
  *The reviewer should ensure that the process control provides indirect integrity monitoring of the membranes, such as online conductivity monitoring. Specific constituents of concerns may need to be tracked by laboratory analysis or onsite field tests. Flow, differential pressure across the RO stages, feed pressure to the RO stages, and temperature must be monitored and recorded by the operator or using an online SCADA system. The report should specify a way to determine the need for cleaning and replacement of membranes. Process control procedures for pre and post treatment must be outlined in the report including any items in the feed water than harm the membrane and post-treatment to reduce finished water corrosivity.*

# XI. Review of the Engineering Design Report – Glossary

***Bypass Stream*** – The portion of the feed water that is allowed to move past the RO system and combine with the RO system permeate.

***Concentrate***[A] – The membrane output stream that contains water which has not passed through the membrane barrier, and concentrated feedwater constituents that are rejected by the membrane (also known as *reject, retentate, brine,* or the *residual stream*).

***Elements***[A] – The smallest component of a membrane unit without a pressure housing. A common term for spiral-wound RO and NF membranes with concentrate and permeate spacers, central permeate tube, outer wrapping material, and anti-telescoping devices at each end.

***Foulant***[A] – A contaminant that gradually accumulates on a membrane surface or within a porous membrane structure that inhibits the passage of water, thus decreasing permeability.

***Lead Element*** – The first element in a pressure vessel that feed water contacts.

***Pass*** [B] – For a membrane treatment process, a single treatment step or one of multiple membrane treatment steps producing a product stream. For example, a two-pass seawater reverse osmosis desalting system may include seawater reverse osmosis membranes in the first pass, producing permeate (product) that is then repressurized and further desalted by brackish water reverse osmosis membranes in the second pass, yielding a product water of even lower total dissolved solids. Sometimes a membrane system that contains more than one pass is referred to as a permeate-staged system.

***Permeate***[A] – The portion of the feed stream that passes through an RO membrane.

***Recovery***[A] – The ratio of the permeate flow to the feed flow, generally expressed as a percentage.

***Scalant***[A] – Inorganic salts that precipitate on the feed-concentrate side of a membrane.

***Silt Density Index (SDI)*** [A] – A dimensionless value resulting from an empirical test used to measure the level of suspended and colloidal material in water. Calculated from the time it takes to filter 500 mL of the test water through a 0.45-µm-pore-diameter filter at 30 psi pressure at the beginning and at the end of a specified test duration.

***Stage***[A] – A set of pressure vessels installed in parallel.

[A] American Water Works Association, Manual of Water Supply Practice, M46 Reverse Osmosis and Nanofiltration, Second Edition, 2007

[B] American Water Works Association, The Drinking Water Dictionary, 1999

*Finalized and Approved by:*
*Linda Brookins, Water Supply Division Director, 12/10/2012* If no formal expiration date has been established for this staff guidance, it will remain in effect until superseded or canceled.

## Revision History

| Date | Action | Action by |
|---|---|---|
| 12/10/2012 | Approved | Linda Brookins |
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